INDOOR AIR QUALITY ASSESSMENT

Pepperell Town Hall
1 Main Street
Pepperell, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Emergency Response/Indoor Air Quality Program
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Ed Wirtanen, Health Agent for the Pepperell Board of Health (BOH), an indoor air quality assessment was done at the Pepperell Town Hall (PTH), 1 Main Street, Pepperell, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (DPH), Bureau of Environmental Health Assessment (BEHA). Employee concerns about odors in a meeting room on the second floor of the building prompted the investigation. On March 6, 2003, Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), made a visit to this building. Mr. Whirtanen accompanied Mr. Feeney during the visit.

The PTH is two-story, clapboard building located in Pepperell Center. The date of construction is estimated to be late 1800s. The building was renovated in the 1970s, which added offices to the basement level, reconfigured the office space on the first floor and installed a heating, ventilating and air-conditioning (HVAC) system on the first floor and basement level. The second floor of the building contains an auditorium. Sash window systems were openable throughout the building.

Methods

Air tests for carbon monoxide (CO), carbon dioxide (CO_2), temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The PTH has an employee population of 20 with approximately one hundred members of the public visiting daily. The tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that the CO_2 levels were below 800 parts per million of air (ppm) in all areas surveyed, indicating adequate ventilation. However, none of the HVAC systems were operating during the assessment. The sole source of fresh air in the building resulted from air penetrating through cracks and seams around window frames and the periodic opening of exterior doors.

There are several HVAC systems in the building, all of which were deactivated during the assessment. An air-conditioning air-handling unit (AHU) was installed in the rear of the first floor. This AHU services office space on the first floor only. The fresh air intake for this system is installed in the exterior wall behind the town hall (see Picture 1). Air is distributed by diffusers connected to ductwork. The return vent for this AHU is installed in the rear wall of first floor offices (see Picture 2). The return vent was sealed with plexiglas to prevent cold air penetration into the office. The basement level has an AHU connected to ductwork whose sole purpose is to recirculate air. The auditorium has fan coil units (FCUs) that provide heat in cold weather, but do not introduce fresh air while operating (see Picture 3).

In order to have proper ventilation with a mechanical supply and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

CO_2 is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As CO_2 levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for CO_2 is 5,000 ppm. Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning CO_2, please refer to Appendix A.

Temperature readings ranged from 69^{o} F to 74^{o} F in occupied areas, which were very close to the BEHA recommended comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Temperature control is difficult in an old building without the ventilation systems functioning (e.g. deactivation of AHUs).

Relative humidity measurements ranged from 18 to 23 percent, which were below the BEHA comfort range. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

The HVAC system has the capacity to provide air conditioning during warm weather. Each AHU has a metal pan/condensation drain system installed. When warm, moist air passes over a surface that is colder than the air, water condensation can collect on the cold surface. Over time, water droplets can form, which can then drip from the suspended surface. For this reason, HVAC systems are equipped with drainage pans beneath cooling coils to drain condensate that forms as moist outdoor air is cooled. The AHU condensation pan on the ground floor empties into a condensation pump (see Picture 4). The pump is connected to a pipe system that drains water from the unit. Each pump should become activated once water accumulates within the base of the unit. The pump and attached hose (see Picture 5) appeared to be coated with debris that would serve as a medium for microbial growth.

The auditorium has a ceiling tile system that is affixed directly to the ceiling lathe (see Picture 6). A significant number of ceiling tiles appear to be water-damaged by roof leaks. Water-damaged ceiling tiles may provide a medium for microbial growth and should be replaced after a water leak is repaired. Replacement of these ceiling tiles is difficult, since their removal appears to necessitate the destruction of the tile, which can result in the aerosolization of particulates.

Several offices contained a number of plants (see Picture 7). Plant soil, standing water and drip pans can be a potential source of mold growth. Drip pans should be inspected periodically for mold growth and over watering should be avoided.

Other Concerns

A gas-fired boiler is located in the basement. In order to provide efficient combustion for the gas jet in the boiler, an adequate supply of combustion air is needed to provide oxygen. A make up air vent is usually located in an area near the furnace. The make up air vent for the furnace was sealed with fiberglass insulation (see Picture 8). With the make up air vent sealed, combustion air is drawn from the interior of the building. This condition can result in incomplete combustion of fuel, which can produce by products such as carbon monoxide (CO). Due to the configuration of the water heater and its exhaust vent, CO measurements were taken in the basement prior to and after activation of the hot water heater. No detectable levels of CO were measured at any time during the assessment. However, a number of penetrations were noted in the walls and ceiling of the boiler room which can serve as pathways for boiler room pollutants to migrate into occupied areas (see Pictures 9 & 10).

The process of combustion produces a number of pollutants, depending on the composition of the material. In general, common combustion emissions can include CO, CO_2, water vapor and smoke. Of these materials CO can produce immediate, acute health effects upon exposure. The MDPH established a correction action level concerning CO in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a CO level over 30 ppm taken 20 minutes after resurfacing within the rink, that operator must take actions to reduce CO levels (MDPH, 1997).

The US Environmental Protection Agency has established National Ambient Air Quality Standards (NAAQS) for exposure to CO in outdoor air. CO levels in outdoor air must be maintained below 9 ppm over a twenty-four hour period in order to meet this standard. These NAAQS are used by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) as measures for assessing indoor air quality in buildings (ASHRAE, 1989). As discussed previously, no measurable levels of CO were detected in the building during the assessment.

Sewer gas odors were reported in a closet of a first floor private office. Sewer gas odors were detected around a vent pipe in the closet (see Picture 11). Two sections of the vent pipe were joined to the floor pipe by a rubber-lined metal collar. The pipe running to the roof appeared to be slightly off-line with the floor pipe. This mismatched alignment resulted in bending of the rubber-lined clamp, creating a space in the interior of the vent pipe. This space allows for sewer gas to escape into occupied areas. Sewer gas can contain hydrogen sulfide, a gas heavier than air, which can be irritating to the eyes, nose and throat.

The various HVAC system components were equipped with disposable filters. Filters on auditorium FCUs were not fit into place. The frame of the filter in the ground floor AHU was damaged and no cover exists to seal the filter slot (see Picture 12). This can allow for unfiltered air to bypass the filter and be distributed by the FCUs during operation. The filter medium used in these metal racks provides minimal filtration of respirable particulates. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for dust spot efficiency of a minimum of 40 percent (Minimum Efficiency Reporting Value equal to 9) would be sufficient to reduce many airborne particulates (Thornburg, 2000; MEHRC, 1997; ASHRAE, 1992). Note that increasing filtration can reduce airflow (called pressure drop) that can reduce efficiency due to increased resistance. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

Photocopiers exist in an unvented room on the first floor. VOCs, heat and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). Without local exhaust ventilation these pollutants can build up and lead to indoor air quality/comfort complaints.

Conclusions/Recommendations

In view of the findings at the time of this visit, the following recommendations are made:

1) Install a wall-mounted CO alarm with digital readout in the basement stairwell. CO levels should be checked daily after the boiler is fired up during the heating season.
2) Provide adequate combustion air for the water and space heaters. Restoring the fresh air intake in the boiler room is necessary. Consult with the local fire prevention officer/building code official to determine an appropriate method to provide combustion air.
3) Consideration should be given to rendering the boiler room as airtight as possible to eliminate the draw of combustion air to occupied areas. Measures would include:

i) Installing weather-stripping along the doorframe of the boiler room.

ii) Installing a door sweep at the bottom of the door of the boiler room door.

iii) Sealing spaces around utility pipes that enter occupied areas through the floor.

4) Reseal/replace the sewer vent cuff in the first floor office closet to render the pipe airtight.

5) Clean the AHU condensation pump and replace attached plastic hose. These pumps should be inspected for function every spring prior to activation of the air-conditioning system. Water should be poured into condensation pans and monitoring water removal. The interior collectors for condensation drains should be cleaned before and after the cooling season to prevent the accumulation of media that could support mold growth.

6) For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations). Consider obtaining a vacuum cleaner equipped with a high efficiency particulate arrestance (HEPA) filter to trap respirable dusts.

7) Reduce the number of plants in offices.

8) Water-damaged ceiling tiles should be replaced. These ceiling tiles can be a source of microbial growth and should be removed. Sources of water leaks (e.g. window frames and roof) should be identified and repaired. Once ceiling tiles are removed, examine the non-porous surface beneath and disinfect with an appropriate antimicrobial.

9) Consider installing an exhaust fan in the photocopier room.

References

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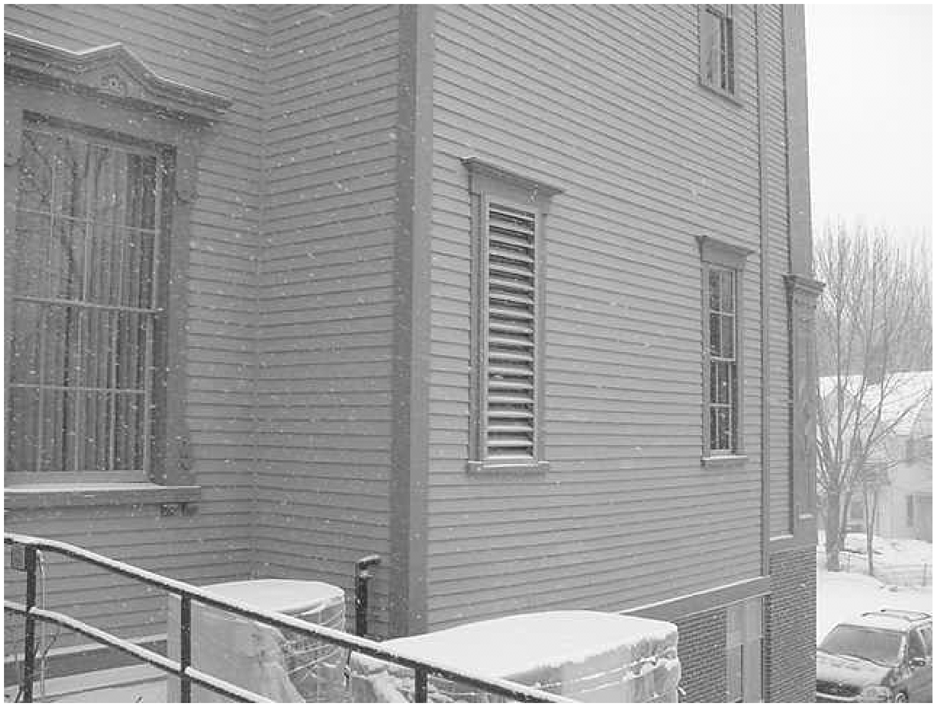
Picture 1



Fresh Air Intake, First Floor

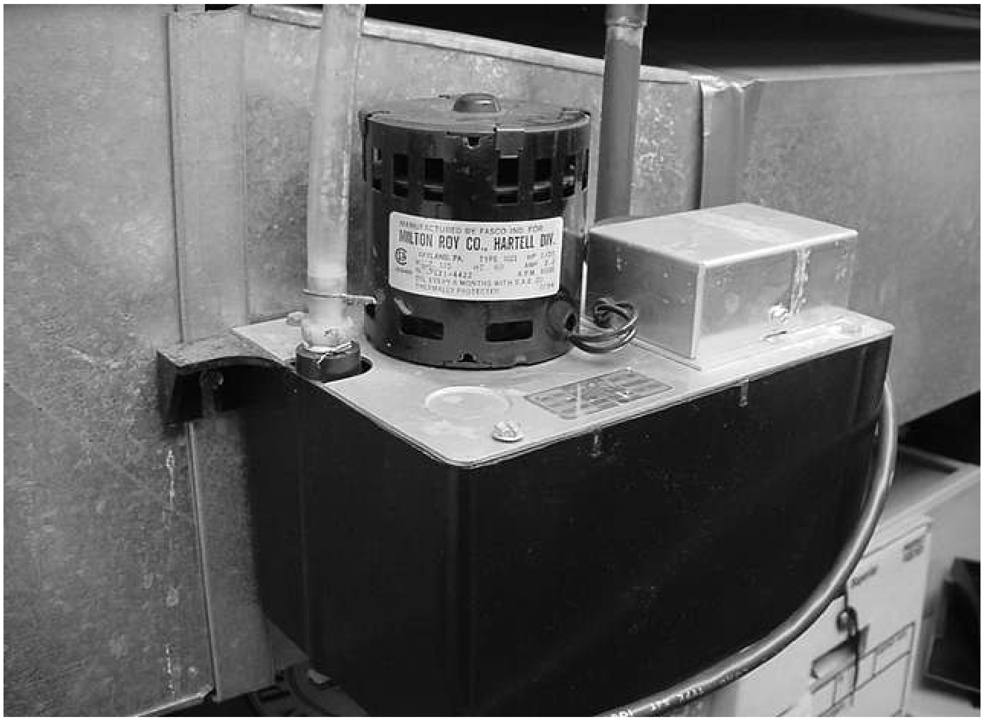
Picture 2

Return Vent Sealed with Plexiglas, First Floor

Picture 3

Auditorium FCU

Picture 4



Condensation Pump, Ground Floor HVAC System

Picture 5

Hose to Condensation Pump, Ground Floor HVAC System, Note Coating Inside Hose

Picture 6

Ceiling Tiles, Auditorium

Picture 7

Plants, First Floor Offices

Picture 8

Combustion Air Vent Was Sealed With Fiberglass Insulation, Boiler Room

Picture 9

Ceiling and Wall Penetrations, Boiler Room

Picture 10

Ceiling Penetrations, Boiler Room (Note Spaces around Sheet Metal)

Picture 11

Sewer Gas Vent Pipe Cuff in the Closet, Note Buckling of Gasket

Picture 12

Damaged Air Filter, Ground Floor AHU

TABLE 1-1

Indoor Air Test Results – Pepperell Town Hall – Pepperell, MA **March 6, 2003**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outside (Background)	360	32	56					
Lunch Room	622	63	25	0	Y	N	N	Wet plaster
Auditorium	486	48	32	0	Y	N	N	
Town	492	62	30	0	Y	N	N	WAC – no filter Door open
Building Department	596	69	19	1	Y	Y	Y	Supply and exhaust off Plants
Planning Department	547	70	19	0	Y	Y	Y	Supply and exhaust off, water-damaged ceiling plaster, holes to
Health Department	639	71	21	0	Y	Y	Y	Supply and exhaust off
Town Clerk	593	71	20	1	Y	Y	Y	Supply and exhaust off Air freshener – Lysol
Treasurer/Collector	594	72	19	2	Y	Y	Y	Supply and exhaust off
Assessor	602	73	19	3	Y	Y	Y	Supply and exhaust off Plant
Photocopier Room	568	74	19	0	Y	Y	Y	Supply and exhaust off Water-damaged ceiling plaster
Town Clerk	607	72	18	1	Y	Y	Y	Exhaust off, plants Loose pipe cap

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2-1

Indoor Air Test Results – Pepperell Town Hall – Pepperell, MA **March 6, 2003**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Town Accountant	627	69	23	2	Y	N	N	Plants Door open
Selectmen	595	71	21	1	Y	N	N	Plants Door open
Town Administrator	593	71	21	0	Y	N	N	Plants Door open
Coffee Room	561	70	23	0	N	Y	Y	Supply and exhaust off Photocopier

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%